Commotio Cordis

Background

Sudden unexpected cardiac death that occurs in young people during sports participation is usually associated with previously diagnosed or undiagnosed structural or primary electrical cardiac abnormalities. Examples of such abnormalities include hypertrophic cardiomyopathy, anomalous origin of a coronary artery, arrhythmogenic right ventricular cardiomyopathy, and primary electrical disorders, such as congenital prolongation of the QTc interval and catecholaminergic, polymorphic ventricular tachycardia (CPVT). **Sudden death due to ventricular fibrillation may also occur following a blunt, nonpenetrating blow to the chest, specifically the precordial area, in an individual with no underlying cardiac disease. This is termed commotio cordis.**

Much of our understanding of the clinical and pathophysiologic aspects of commotio cordis is the result of work by N.A. Mark Estes III, MD, and Mark S. Link, MD, from the New England Cardiac Arrhythmia Center at the Tufts University and School of Medicine in Boston, Massachusetts and data derived from the US Commotio Cordis Registry (Minneapolis, Minnesota).

Relatively recent data from the registry of the Minneapolis Heart Institute Foundation show that commotio cordis is one of the leading cause of sudden cardiac death in young athletes, exceeded only by hypertrophic cardiomyopathy and congenital cornoary artery abnormalities.[1]

Commotio cordis typically involves young, predominantly male, athletes in whom a sudden, blunt, nonpenetrating and innocuous-appearing trauma to the anterior chest results in cardiac arrest and sudden death from ventricular fibrillation. The rate of successful resuscitation remains relatively low but is improving slowly. Although commotio cordis usually involves impact from a baseball, it has also been reported during hockey, softball, lacrosse, karate, and other sports activities in which a relatively hard and compact projectile or bodily contact caused impact to the person's precordium. While only 216 instances have been reported to the US Commotio Cordis Registry (as of 2012),[2, 3] this is probably a considerable underestimation of its true incidence since this entity still goes unrecognized in many instances and continues to be underreported.

History

In most reported cases of commotio cordis, sudden death follows a seemingly inconsequential, nonpenetrating blow to the chest. Individuals who have witnessed the events universally believed that the chest trauma was of insufficient force to cause major injury and was out of proportion to the outcome. The person who is struck collapses immediately in most instances. **In some instances, the individual has a transient period of consciousness, during which a brief purposeful activity, movement, or behavior (e.g., picking up and throwing a ball, crying) is performed before final collapse.**

According to the latest reported data from US Commotio Cordis Registry, at the time of the incident, 53% of persons struck were engaged in organized competitive athletics. The remainder were involved in normal daily activities (23%) or recreational sports (24%).

Baseball, softball, hockey, and lacrosse are the sports most commonly involved. Other associated organized activities included soccer, football, boxing, and karate. Cases involved with daily activities have included playful boxing, a "remedy" for hiccups, parental discipline, being struck by a snowball, and an accidental kick during cheerleading, among others.

In most instances (58%), the person was struck by a projectile, which was most commonly a pitched, thrown, or batted baseball or softball estimated to be traveling 30-50 mph, at most. Other

projectiles have included hockey pucks and lacrosse balls. In 42%, chest trauma resulted from bodily contact with another person or a stationary object. Examples of this have included a player's helmet during a football tackle, the heel of a hockey stick, a karate kick, and a body collision.

Survival after a commotio cordis event has become less of an exception compared with earlier eras. Although efforts at resuscitation occur frequently, often involving trained bystanders or emergency medical technicians, the onset of CPR is often delayed because observers underestimate the severity of the trauma or believe that the wind has been knocked out of the person. Survival has usually been associated with effective and timely CPR efforts and defibrillation that occur within 3 minutes of the collapse. The survival rate is only 5% or less in cases in which resuscitative efforts were delayed longer than 3 minutes. Although numerous individuals have been resuscitated with the restoration of a perfusing heart rhythm, many of these individuals have experienced irreversible ischemic encephalopathy and ultimately died as a result of the injury.

Medical Care

The treatment of commotio cordis is not different from any other cardiopulmonary emergency associated with a nonperfusing cardiac rhythm. For victims of witnessed ventricular fibrillation arrest, as occurs in commotio cordis, early cardiopulmonary resuscitation (CPR) and rapid defibrillation can significantly increase the chances of survival.

The *2010 AHA Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care* recommend early CPR that emphasizes chest compressions immediately after the emergency response system has been activated. The guidelines deemphasize the importance of rescue breaths and pulse checks. Although a chest compression to ventilation ratio of 30:2 and a compression rate of at least 100 per minute are still recommended for adults and children (above age 1 y), bystander "hands-only" CPR (compression only) also significantly improves survival compared with no bystander CPR. Rapid defibrillation significantly increases the chances for survival to hospital discharge. CPR, beginning with chest compressions, should resume immediately after a shock and should continue for 2 minutes before a rhythm or pulse check is conducted.

Performing CPR while the AED or defibrillator is readied for use is strongly recommended. A shorter time interval between the last chest compression and the shock is directly correlated with the success of defibrillation.

The relatively low rate of survival from commotio cordis is probably caused by the delay in instituting effective CPR measures because bystanders frequently fail to appreciate the severity of the event, lack knowledge of commotio cordis, or mistakenly believe that the trauma was insignificant. Many observers have commented that they believed that the wind was knocked out of the person. Experience suggests that survival is associated with resuscitation efforts begun within 1-3 minutes of collapse.

Electrical defibrillation

The hallmark of effective resuscitation is rapid, direct current defibrillation. Time to defibrillation is probably the single most important determinant of survival in cardiac arrest. The likelihood of successful defibrillation decreases rapidly over time, in part because ventricular fibrillation generally evolves to asystole within a few minutes. Experimental data gathered using the commotio cordis swine model suggest that defibrillation within 1 minute of ventricular fibrillation

onset results in a 100% survival rate and that defibrillation after 2 minutes results in an 80% survival rate. In animals in which ventricular fibrillation was present for more than 4 minutes, the survival rate was 0% unless CPR was instituted after defibrillation (in which case, the likelihood of survival increased to 65%). In humans, every 1-minute delay in defibrillation beyond the first 3 minutes decreases the likelihood of survival by approximately 10%.

Because emergency paramedical technicians cannot be expected to arrive at the scene of a cardiac arrest in less than 5 minutes, the expanded use of public-access automated external defibrillators (AEDs) may save the lives of countless young people who experience cardiac arrest due to blunt trauma to the precordium. AEDs, even when used by persons with minimal training, can recognize and automatically terminate fatal arrhythmias. AEDs are now approved for use in children as young as 1 year. Ideally, AEDs should have a specific "low-output" setting or a special pediatric pad and cable set which attenuates the charge for use in children aged 1-8 years. Even without these, all AEDs can be used in children of any age older than 1 year.

Precordial thump

Use of the precordial thump during CPR is controversial. No prospective studies have evaluated the efficacy of precordial thump in resuscitation. Recently, limited studies in animals and humans have shown precordial thumps to be ineffective in terminating ventricular fibrillation.[6] The *2010 AHA Guidelines* for adult ACLS mention that one immediate precordial thump may be considered after a witnessed cardiac arrest if an AED or defibrillator is not immediately available. Precordial thump is not mentioned at all as an option in pediatric CPR or pediatric advanced life support (PALS).

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